

A Feasibility Study on the Development and Integration of a Teaching Aid for Pharmacology

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Abstract

Traditional methods of teaching and learning in higher education are ever-evolving. This report assesses the feasibility of developing a teaching aid for pharmacology modules. Focus groups were established to gauge student and staff opinions on the use of teaching aids and an extensive literature review was conducted. The study identifies and critically evaluates a range of possibilities that could be developed and discusses practical issues such as accessibility, inclusion and assessment, associated with these potential aids. This initial study concludes that a suitable aid could take the form of a student-led development of a wiki-type website resource that included access to case-studies giving students 'real-life' experience of the concepts being studied. This type of project requires considerable time and financial support; nevertheless, this idea could be extended for many drugs and could be used in any health science course.

Keywords

Assessment; Engagement; Inclusion; Interactive Learning; Teaching Aid

Introduction

Traditionally teaching was regarded as being the imparting of knowledge, and that this knowledge should be delivered rather than acquired. Modern teaching theory proposes that teaching should center on the student rather than the knowledge [1]. The student should actively engage in the development of ideas, as knowledge is seen as part of the learning activity [2].

Research from Race and Brown proposed that successful learning requires five factors: (1) the student must possess their own intrinsic motivation to learn; (2) the student must be motivated by an extrinsic need to learn; (3) the student must learn through practice; (4) the student must learn from feedback provided; and (5) they must digest or reflect on what has been learned. For effective learning all these factors should exist at all times

and continuously interact [3].

A teaching strategy should aim to develop the students' skills and nurture their understanding of knowledge. The main learning activities that students participate in could be summarised as attending (therefore gaining access to knowledge), practice (provides opportunity to gain understanding and experience), discussion (opportunity for reflection) and articulation (demonstrating the ability to recite what has been taught). Academic learning operates on both a theoretical and practical level, both of which are needed for understanding to develop. Knowledge is not just experience of a phenomenon, it is understanding the descriptions of such phenomena and is assisted by learning through experience [2].

Learning and Reflection

It is becoming a more commonly held view that reflective activity is important in the learning process. Reflection can be both individual or through discussion and is required to make sense of information [4]. To realize a concept, students must be able to use feedback supplied by others and adjust their conception of that topic to meet the learning objectives [2]. Learning and reflection through discussion is not solely provided by the teacher. Learning is also regarded as a social process of knowledge creation, meaning students also benefit from discussion among each other and sharing their knowledge and experience. There is the potential to use these networks to the benefit of their education [5].

Collaborative learning and group feedback can improve learning and enhance students' understanding. A student who has only recently gained understanding may better be able to describe a concept to a fellow student than someone who has

understood it for many years [1]. Collaborative learning contributes to knowledge convergence – that is, the adoption of ideas and the common understanding of concepts. Over the course of a discussion a person will contribute their own knowledge which may be adopted by others. This occurs best when the collaborators must reach a consensus, rather than when one party imparts their knowledge to another [6].

Rationale for this study

This study was devised to assess the feasibility of developing teaching aids which could be used in an undergraduate Master of Pharmacy (MPharm) academic programme. The target audience are students in years 3 and 4 of the 4-year MPharm course. In the UK, all students who aspire to practice as registered pharmacists must undertake the MPharm qualification. This has been the recognised qualification since the late 1990's when the 3-year undergraduate Bachelor degrees (BSc. or BPharm.) were replaced by the 4-year MPharm undergraduate award in all UK Higher Education Institutions who offer pharmacy training. Upon graduation from the 4 year MPharm academic program, students must then successfully complete 1 year of pre-registration training prior to registering as a pharmacist.

This paper shall discuss the feasibility of developing a teaching aid to complement drug metabolism and/or pharmacology modules by examining potential formats the aid could take and reflecting on how feasible such options are by referring to data obtained from discussion forums that were held to assess the opinions of staff and students on the use of teaching aids. This report also discusses the practicalities of using teaching aids by examining issues surrounding inclusion for all students irrespective of disability or access to resources.

Accessibility to Teaching Aids and All-Inclusive Learning

The most vital quality that any teaching aid must possess is accessibility to allow for all-inclusive learning [7, 8]. An inaccessible teaching aid is an ineffective teaching aid. Irrespective of the quality of the teaching aid, if students cannot gain appropriate access to it they cannot benefit from it. This could involve something as practical as ensuring proper wheelchair access to sites which accommodate the aid. It is also imperative that academic staff appreciate that

students who require differential treatment may find this embarrassing and try to minimize the attention drawn to them regarding such difficulties [7]. The importance of being discreet about specialist needs was re-iterated during a focus group held with secondary school teachers.

When considering all-inclusive learning we must remember the hidden disabilities. Brown and Race state that the prevalence of hidden disabilities in further and higher education is around 4% [7]. Whilst this is lower than the population average of 10-20%, it still represents a substantial number of affected students. Hidden disabilities include color blindness, while common partial hidden disabilities include partial sightedness, hearing loss (whether profound or slight) and dyslexia [7].

The most challenging aspect when providing for disabilities in higher education is the lack of transparency with respect to such disabilities. In secondary education (within the UK), a Special Educational Needs Coordinator (SENCO) has close contact with affected pupils and develops an Individual Education Plan (IEP) for each pupil. The IEP is distributed to each teacher who has contact with the pupil and notifies them of strategies to overcome the difficulties and also minimize the disruptive potential of such difficulties. In stark contrast, university students in the UK are not obliged to declare any disabilities to the institution (either during application or while enrolled) therefore academic staff may be unaware of disabilities which exist with their students.

In 1999-2000 the Higher Education Statistics Agency (HESA) website reported that 4.2% of first year UK domiciled undergraduate students declared a disability. In 2006-2007 this figure had risen to 6.8%. It is important to note that HESA advises these reported figures may not be representative of the total student population since students are not obliged to declare disabilities.

Accessibility can more subtly involve affording students less restricted access to the aid. For example, if the developed aid was a computer-based or electronic learning package, then an aid which could be remotely accessed online would be significantly more accessible than the same aid which could only be accessed through specific university computer centers. There are obvious practical problems with certain teaching aids (such as laboratory practicals) that would

prevent these types of aids from utilizing an online approach. Accessing teaching aids online enables users to gain access at the point of need, rather than exclusively at the aid's physical location. In the case of electronic aids, the students' focus group identified restriction to a specific site as a major barrier to accessing and engaging with electronic aids.

The possibility of a sufficient number of students accessing online teaching aids would depend primarily on the access they have to a computer and to the internet. A recent survey in the School of Medicine, Dentistry and Biomedical Sciences at Queen's University Belfast reported that of 269 second year medical students, 90% had access to a computer at home and 82% of students had access to broadband (personal communication). This data reflects the real possibility of accessible online teaching aids.

Whilst remote access to electronic aids would certainly make it easier for the student to readily access the teaching material, there are limitations to their application. In their focus group, secondary school teachers revealed that the student uptake of their new online learning system had been poor. Students admitted that despite it being compulsory they 'just looked through it quickly and had difficulty recalling the material at a later date.'

There is also reluctance from lecturers to put all lecture material online for students to access from remote locations. In the academic staff's focus group everyone agreed that if all the teaching material from the degree course was available online that this could disengage the students from the lecturer, making the course a somewhat 'virtual degree', which is more akin to a series of distance learning courses.

Another aspect of all-inclusive learning is recognizing that not every individual learns best from the same style of teaching. Fleming and Mills [9] describe four distinct classes of learner: visual, auditory, read/write and kinesthetic. Recent research by the author [10] supports the idea that when students study using their own learning style preference, it has a direct positive impact on their performance in assessment, the paper also recommends the benefits of using a variety of teaching techniques to encompass as many learning style preferences as possible that may invariably be in any class. For a teaching aid to be all-inclusive and accommodate each student's learning requirements, provisions for each of the main classes of learner should be included within the aid. The ability to fully

accommodate each student's preferred learning styles in one teaching aid poses a tremendous challenge to teachers. The academic staff agreed, it is nearly impossible to incorporate this in just one teaching aid therefore it is always advisable to vary the use of different types of teaching aids to encompass as many different learning style preferences as possible [10].

Methods of Teaching and Learning

Before developing any teaching aid it is important to consider the qualities it must include. Education should be more than merely exposing students to a subject. The most effective form of teaching is probably the one-to-one tutorial between teacher and student, but this is time consuming and impractical with increasing student numbers and simultaneous staff reductions.

Laurillard describes the four main characteristics of the learning process as being discursive, adaptive, interactive and reflective [2]. Each medium has its own characteristics that may benefit or impair learning [5]. For teaching aids, the correct medium or combination of media should be selected and the four learning characteristics represented.

Lectures

There are a number of teaching aids used throughout the MPharm programme however the most prevalent teaching method is the lecture. Students acknowledged that they found lectures beneficial while lecturers admitted that they are the principle route of delivery of information to students on the MPharm degree. Nevertheless, there are disadvantages associated with lectures. The biggest problem is lack of engagement and loss of the student's concentration. This age-old problem in education was recognized by students and staff alike in the various discussion forums. A study by McKeachie reported that following a one hour lecture, students could recall 70% of the material covered in the first 10 minutes of a lecture but only 20% of the material from the final 10 minutes [11].

Often the purpose of the other teaching aids used in the course is to complement lectures and to re-enforce students' knowledge from the lecture, rather than as the primary route for information delivery.

The literature would suggest that delivery of the information on pharmacology and drug metabolism in a lecture format would still be advantageous before

the students were required to engage with a teaching aid [12]. Such an approach would allow students to have an understanding and familiarity of the topic before re-addressing, re-enforcing and supplementing key principles in a workshop/tutorial environment. Given the variation in learning style preferences this approach may not appeal to every student, however it offers extra support for students who have failed to fully grasp the lecture information clearly or who wish to understand the concepts more fully thus encouraging deep learning.

Engagement and motivation - the use of case studies as a teaching aid

Any teaching aid should engage students and motivate their desire to understand the information it aims to convey. This should be achieved by incorporating different teaching styles to account for the different preferred styles of learning but should also include other strategies to capture and engage the imagination and attention of students. Even motivating students to access the aid in the first instance can present a challenge and students openly admitted this during their focus group (a point that may not have been so forthcoming had academic staff been present at the focus group).

Petty suggests that student motivation and interest can be stimulated by adopting the 'human interest' angle. Any general principle of an academic idea becomes more interesting if it can be seen from a 'real-life' perspective [13]. Pharmacy students and academic staff recognized this benefit of case studies and the power that a case study has to link material from different theoretical disciplines together in a clinical context. These ideas are also adopted in enquiry- and problem-based learning.

In Fry's book, Beaty describes case studies as complex examples which give an insight into the context of a problem as well as illustrating a point. The piece alludes to the specific benefit of case studies in vocational degrees [12]. Case studies aim to establish the scope of a problem using case details and give the students exercises to complete relating to the case; such exercises can be completed in teams which then encourages more student-centered learning. These ideas were corroborated by secondary school teachers in their focus group and indeed such principles are supported in inter-professional education.

Video and audio education tools

It would be possible to present drug metabolism as an online lecture or series of lectures available in video or audio format that could be streamed or downloaded by students [14]. This could also be supplemented by print copies of lecture notes. One of the reasons printed notes are commonly used is that they are superior in presentation and structure to those students write themselves. Lectures describe concepts; they do not provide experience of them. Video and audio formats work better when aided by print to provide additional visual focus for students; printed notes can incorporate diagrams and other visual representations of what they hear being described. The main advantage of video and audio presentations over traditional lectures is that their pacing can be controlled by the student, but this is no more effective than doing the same when reading a textbook. They also have the capacity for discussion as students can be set tasks between sections, with limited, pre-emptive feedback provided in the form of a summary of expected misconceptions or correct answers [2]; however this form of presentation removes the opportunity for the teacher to engage in discussion or ask questions of students during a lecture.

There are opportunities to incorporate multimedia components into other types of learning resources concerning drug metabolism and pharmacology. If produced correctly, a video can represent the intended concept as an 'experience', supplemented by a description in the form of audio or printed notes, therefore allowing the student to construct knowledge of that concept. Again the video could incorporate prompts for reflection and is controllable [2]. However, these media are not adaptive or discursive. If the subject matter is quite verbose it may not be possible to fully convey it in audio-visual format, but potentially certain aspects could be represented this way. For example, narrated animations such as Flash® Media could demonstrate the mechanism of action of a drug by showing changes that the drug molecules undergo during metabolism. Another animation might demonstrate a metabolic pathway, highlighting each segment in turn and explaining the processes involved at each step.

Computer-based and online platforms

Tutorial programs and tutoring systems are designed to simulate a teacher, and usually provide feedback and tasks to meet the learning objective. Tutorial systems often use multiple choice questions (MCQs)

to identify student misconceptions through extrinsic feedback, but the questions must be carefully phrased otherwise students may form new misconceptions if several different answers seem plausible. A computer-based tutorial should be fully controllable by the student so that they can pursue further examples or revisit a topic they find challenging. Tutorial simulations combine the tutorial program with a simulation to provide an adaptive, interactive medium. The simulation provides intrinsic feedback to develop conceptual understanding, while the tutorial provides extrinsic feedback that complements the intrinsic feedback by providing a response based on the student's actions. Tutorial simulations may potentially be used as an alternative to teacher-student interaction [2].

A simulation is a model of a particular concept allowing students to manipulate inputs in the form of parameters, altering the behavior of the model. It allows complex relationships to be explored and understood and provides intrinsic feedback, essentially allowing the student to experience the concept, rather than just a description of it. If a simulation is used to demonstrate drug metabolism it is important that the instructions for the simulation and the control of its parameters should be phrased in 'real-world' terminology to encourage a qualitative understanding of the relationships. The model does not allow discussion with the teacher or provide extrinsic feedback, so it is possible that the student may misunderstand the concept. However, if a learning goal can be selected at the start of the simulation, it could be programmed to provide extrinsic feedback based on student inputs. Discussion may be induced if students use the simulation in pairs [2], this encourages team-work and communication skills by making the learning exercise more student-centered.

Online discussion groups

A weblog (or 'blog') allows the posting of chronological articles, for others to read and add comments. This can be used by a group of students to collaborate in building their knowledge through sharing and discussion, and allowing lecturers to provide feedback. Students can benefit from the use of syndication software to inform participants of new postings or alterations, so that they are aware of changes to the blog and can respond quickly [14]. It is a form of computer-mediated-conferencing (CMC); an asynchronous online notice board that enables

communication and discussion at any time, over any distance, from a computer [15]. It is a truly discursive media, allowing teacher and student to relate their conceptions and modify these in response to others. It also facilitates the social aspect of learning by allowing discussion between students.

However, the success of CMC depends on the ability to sustain a meaningful dialogue between participants. Discussions should be divided into small, manageable topics as a more specific question is likely to receive a prompt, concise reply and to keep the discussion flowing. Questions should be unambiguous since clarification is likely to be time consuming and impede study [16]. The medium is adaptive as it allows the teacher to steer discussion based on responses. In addition, CMC allows 'lurking' or 'eavesdropping' – students who initially shy away from participating fully or who are otherwise unable to articulate themselves, can benefit from viewing others' postings and the teacher's response before making their own contribution, especially if other postings express similar concerns or misconceptions to their own.

The main drawback of CMCs is that they do not provide intrinsic feedback – students are receiving descriptions of the concepts they are trying to understand, not the essential experience of those concepts which is also required for learning. It is also time-consuming for both student and teacher. CMC is widely used in distance learning, making use of personalized feedback to students and allowing them to communicate informally with each other [3], and is used widely at the Open University [15]. Online discussion might be better reserved for tasks that students are supposed to complete in their own time since time is required to reflect on what has been posted before composing a reply [16].

Computer-mediated conferencing is being used increasingly due to its asynchronous nature and because it allows discourse between students on the subject being taught which encourages peer-to-peer learning. The asynchronous nature of CMC is believed to improve reflection because the respondents have the opportunity to consider their replies in greater detail and convey them in a more suitable manner, compared to the immediacy of a face-to-face conversation. This allows time to view postings and consider what is being asked, and to dedicate more thought to composing replies and framing them in a way that conveys depth of meaning. It also allows several threads of debate or inquiry to be pursued

simultaneously. There is also the possibility that learners may discuss and reflect on the forms of teaching employed, further developing their cognitive skills and providing more accurate and useful feedback about the resource. The stored messages permit students to review their own responses and reflect on their understanding and contribution. However, regulating student activity and correcting any erroneous conclusions that may develop over the discussion, requires the observation and participation of a moderator (usually a lecturer or teaching assistant). This requires training and experience and contributes to the cost of resources involved in establishing the learning material [4]. The presence of a moderator in CMC can increase student interaction with lecturers/tutors, exceeding that which usually occurs in lectures or even tutorials, allowing a greater transfer of knowledge than normal [17].

Wikis

A 'wiki' is a system allowing the building of a set of interlinked web-pages by a number of people through the creation and editing of the pages. This also allows the resource to be updated [14]. The students could be given access to literature on the aspects of a certain drug which they must use to produce a wiki detailing their understanding of the topic and demonstrate their knowledge of the connections between drug dose, metabolism, toxicity and side-effects and how each of these aspects interacts [18]. One major danger with the wiki medium is that it does not provide feedback or reflection, it remains passive. Therefore, if a student creates a new inappropriate link, there is no immediate warning to inform them of the mistake. To overcome this, a wiki could be supported by CMC to encourage discussion and debate between students so that they must reflect on what they have learned and can benefit from the viewpoints of others [14]. This may also prove useful as it may encourage debate among students over those aspects of drugs where there is little or no consensus. In addition, the wiki can reduce the depth of knowledge by segmenting it into a series of information fragments and therefore can undermine the meaning or complexity of the information. Providing the moderator with ongoing access to the wiki during its development would facilitate the monitoring of its progression and allow moderators to provide feedback over the course of the project, helping to prevent major deviations and errors in the

subject matter. Alternatively, the wiki development could take the form of a group project. The groups could be given access to literature on the aspects of a certain drug and each group would then be required to produce a wiki as before.

The Role of the Teacher/Moderator in Facilitating the Teaching Aid

The implementation of new teaching media is often impaired by the costs involved in its development, purchase and implementation. Further costs are involved in training staff and even students in their use. The need to supply tutors to moderate online discussion groups can be labor intensive [19]. Teachers must negotiate goals and timelines, set up new branches and topics for discussion, nurture the collaborative process, and ensure adequate responses and reactions to contributions. Successful moderating by fulfilling these roles requires a considerable effort [2]. Once the resource is designed it is the moderator's responsibility to ensure students are enrolled and have access, especially if the material is password protected. The moderator will oversee the activities of the students, introducing them to the learning resources, guiding the discourse between students and condensing the key conclusions. It would also be their duty to assess students' work and provide the necessary feedback, either through conventional (written or oral) means or using appropriate online methods [19]. This type of teaching aid will require periodic updating, especially in the light of feedback from students and new research, this would also be in the moderator's remit.

Assessment and Feedback of the Teaching Aid

The teaching aid proposed for development could be utilised as an independent learning tool to supplement the students' learning and understanding of concepts previously covered in lectures. In this circumstance, small tasks included throughout the aid or at the end would give the student an indication of how well they understand the concepts and detail covered in the teaching aid. This enhances its effectiveness, improving the learning process for the student. This point is supported by Merricks, (who wrote in the book by Jarvis,) that assessment is basic to learning and that the main reason for assessment is to qualify whether or not the learning objectives have been met [20].

A major problem with independent teaching aids is the lack of motivation for students to access them [13]. Frequently, there is no way of assessing whether students have accessed the aid or if they have understood the concepts within the aid. Furthermore, there is little to motivate the student to take time to access and engage with the aid – the students openly admitted this in their focus group.

In their focus group, the students unanimously agreed that any form of assessment which contributes to their overall module mark may serve as a motivational tool not only to encourage them to access the aid but also to ensure they understand the information within it. The need to incorporate assessment into teaching aids to promote the uptake of such aids is recognized by the academic staff although it is not ideal and can lead to a situation of over-assessment which academic staff find frustrating.

The practical implications of this throughout a degree pathway have to be considered and there appears to be a need to assess the knowledge students have gained from the teaching aid; it also acknowledges the students' efforts. Assessment can be used to gauge the effectiveness of the aid and to measure if it has achieved its intended learning outcomes.

As a means of assessment, essay writing compels the student to reflect upon information so that they may understand and write about it; through feedback it also provides discussion. However the time that elapses between submission and the return of the teacher's comments reduces the benefit it may have and it may be too late to correct some misconceptions [2].

For assessment, it may be possible to produce a series of questions based on patient data in the form a case-study. Using the patient information, students can assess the suitability of treatment for the patient in question. The use of clinical phrasing and terminology in the questions may also enhance experiential learning for students. For online assessment the questions could take the form of MCQs, allowing rapid evaluation and feedback of results. These results could then be personalized in response to the chosen answer to explain the correct answer and correct any misconceptions that led the student to select an incorrect answer. Informing them in this way may allow students to reflect on their answers and how they reached those conclusions; this reflection may further enhance their understanding of the subject. Again, these only provide limited, extrinsic feedback

[2]. This could be used as a supplement to, or replacement for, traditional assessment methods.

In assessing the 'wiki development project' the moderator would need to be competent in the use of wiki software so that they can accurately assess student efforts and provide assistance where required [19]. The blog and editing history of the wiki can be used by the examiner to determine the contributions of each group member. In the case of the group project, it will also reveal how well the group have worked over the course of the project and how the wiki has developed [14]. The construction of a wiki assisted by CMC, satisfies most of the essential criteria for learning. It is discursive, as the students will have to transmit their conceptions to each other, and these are available for the teacher to view and comment upon. The medium is adaptable as students can research those areas of the wiki that are not as fully developed. Opportunity for reflection is again provided by the asynchronous nature of CMC requiring the consideration of replies. Although its main weakness is that it cannot provide any 'real-life' experiences, it at least allows students the experience of researching literature concerning drugs and in doing this they are actively creating their own knowledge of the subject. To overcome the lack of 'real' experience there could be a link to online case-studies (discussed previously) to relate the wiki material to real-life examples.

Irrespective of the type of teaching aid developed, there must be an appropriate protocol in place to allow for effective student feedback on it. The main objective of the teaching aid is to enhance students' learning and understanding of the subject material covered within it therefore it is imperative that this can be evaluated. Teaching staff can evaluate the effectiveness of an aid through assessment of the students, as previously discussed. This gives an indication of how well the aid conveys the information within it and if it fulfils its purpose. It is important not only that students have the opportunity to provide feedback, but that the mechanism is robust enough to facilitate accurate and relevant feedback [21].

CONCLUSIONS

The growing trend within educational practice is to focus on new multimedia technological aids. This does not mean that such aids are superior to more established modes of teaching and in fact it is common for individuals to sit at a computer for an hour and be highly engaged but not really have a firm grip on what

is being taught [21]. The pharmacy students' focus group reported that simply putting educational materials online did not motivate them to access those materials, nor did it improve their ability to retain information.

As well as the failure of computer-based aids to significantly increase engagement and motivation within students, the academic staff focus group stressed the need to be careful with technology and not to use technology simply because it is available. From their experience, this may actually disengage the students and trivialize the material.

The most useful and effective computer-based learning materials must be highly interactive and focused on a very specific topic. The problem with these computer-based programs is that students with very little computer experience can find such programs boring, cold and often impersonal, although lack of computer experience is becoming less of an issue. On the contrary, students with extensive computer experience (perhaps through playing highly interactive games) may also find a computer-based resource less stimulating. Consequently, this student subset can often find computer-based teaching aids boring and dull in comparison. If such packages are to meet their learning objectives they must be educationally sound, attractive and easy to use [13].

This investigation has reviewed the possibility of developing an educational tool to aid teaching of pharmacology and drug metabolism, and ascertain what educational medium would be most suitable. Before this can be put into effect further considerations must be reviewed, including budgetary constraints, availability of staff, selection of the appropriate software, security, hosting etc. There will also have to be continuing literature research regarding the drugs being used, to keep abreast of advances being made in the understanding of their metabolism, toxicity, side-effects etc. Nevertheless, it is feasible to present the information on drug metabolism as an online learning resource. However, the best medium to achieve this would not actually be a method of conveying information, but allowing the students to develop their knowledge themselves in an enquiry-based learning approach. This could take the form of a group project whereby students work in groups to construct a wiki site based on relevant research the students have collected themselves, assisted by CMC and supported by a teacher overseeing progress. The combination of wiki and

CMC allows discussion, adaption and reflection in learning. Although the level of interaction between students and teacher will vary between groups, the students would be actively involved in developing their own knowledge. A project such as this would help students to better understand the complexity of certain drugs' pharmacology, as they would have to make the connections between the various pharmacological aspects for themselves.

Implementation depends on the resources available. This requires greater expenditure – the cost of the software and its integration, training staff in its use, training students how to construct pages in a wiki, time spent by staff moderating. If time and money are limited, a compromise may involve making relevant lectures available in video or audio format.

This principle could be expanded to complement the teaching of numerous classes of drugs perhaps setting the students to access the literature and create their own knowledge surrounding the concept outlined here. The aid could be adopted for use in pharmacology programmes on a number of health science courses such as nursing, medicine, biomedical science, biochemistry, medicinal chemistry etc. by incorporating case-studies relevant to the specific disciplines.

Many teachers are concerned that online learning has the potential to diminish their management of students' education. With recent advances in technology, especially the internet, students have greater freedom to access knowledge and information than at any time previously, much of which may not be peer-reviewed [1]. However, the vast majority of students participating in online courses believe that they still need some guidance [19] therefore the role of teachers in the future may not be to provide knowledge but to guide and facilitate students in their exploration and understanding of course material.

Author Introduction

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REFERENCES

- [1] P. Race, Innovations in Education and Training International, 35: 262-271 (1998).
- [2] D. Laurillard, Rethinking university teaching: a framework for the effective use of educational technology, Routledge, London (1993).
- [3] P. Race, The lecturer's toolkit: a practical guide to learning, teaching & assessment, RoutledgeFalmer, London (2007).
- [4] G. Salmon, British Journal of Educational Technology, 33(4): 379-391 (2002).
- [5] J. Sandars and C. Haythornthwaite, Med Teach 29(4): 307-10 (2007).
- [6] A. Weinberger, K. Stegmann and F. Fischer, Learning and Instruction 17(4): 416 (2007).
- [7] P. Race and S. A. Brown, The lecturer's toolkit: a practical guide to teaching, learning and assessment. Kogan Page, London (1998).
- [8] A. Armitage, Teaching and training in post-compulsory education, Open University Press, Maidenhead (2003).
- [9] N.D. Fleming and C. Mills, To Improve the Academy 11: 137-155 (1992).
- [10] K.M.A. Rogers, Journal of Further and Higher Education 33(1): 13 – 21 (2009).
- [11] W.J. McKeachie, M. D. Svinicki and B. K. Hofer, McKeachie's teaching tips: strategies, research, and theory for college and university teachers, Houghton Mifflin, Boston, (2006).
- [12] H. Fry, S. Ketteridge and S. Marshall, A handbook for teaching and learning in higher education: enhancing academic practice, Kogan Page (1999).
- [13] G. Petty, Teaching today: a practical guide, Stanley Thornes, Cheltenham (1998).
- [14] T. Franklin and M. van Harmelen, Web 2.0 and Content for Learning and Teaching in Higher Education, Joint Information Systems Committee (2007).
- [15] G. Salmon, Management Learning 31(4): 491-502 (2000).
- [16] Q. Wang and H. L. Woo, British Journal of Educational Technology, 38(2): 272-286 (2007).
- [17] D. Laurillard, the Virtual University: Value and Feasibility. Higher Education for Capability Conference, Beyond Competence to Capability and the Learning Society (1995) Manchester, UK.
- [18] H. Davis, D. Millard, G. Wills, L. Gilbert, Y. Howard, R. Sherratt, et al. (2006). FREMA Final Report.
- [19] P. Goodyear, G. Salmon, J. M. Spector, C. Steeples and S. Tickner Educational Technology Research and Development, 49(1): 65 (2001).
- [20] P. Jarvis, The theory and practice of teaching, Kogan Page, London (2002).
- [21] S. Brown and P. Race, Lecturing: a practical guide, Kogan Page, London (2002).